abruptly at the two ends; beyond the wave-lengths μ.43 and μ.66 they affirm that absolutely no differences of color are perceptible, but only differences of brightness. Since the method of mean errors is considered by some to be objectionable, Uhthoff has repeated these experiments, using the same apparatus, but the method of just perceptible differences. His results resemble very closely those of the last two observers, but they differ somewhat at the ends. The difference is such as to leave it quite undecided whether it is caused by the difference of method or by the individual differences of the eyes experimented upon. Since the principal object of the investigation was to compare the methods, it is a pity that both methods could not have been applied by the same observer.

Peirce found the eye more sensitive to change in the yellow than in the blue; the reverse of that was found by all the other observers, but that is probably because his curve represents the mean of many different observers. He did not detect the changelessness of the two end-portions of the spectrum, but this, Uhthoff considers, is because he did not make the colors compared equally bright. The fact, if it is a fact, is of great importance for the theory of color-vision, and it would be well if it could be confirmed by other observers. Uhthoff says that the securing of equal brightness is less necessary in the middle of the spectrum than at the ends. This is strange, because, according to Langley's brightness-curves, the brightness is changing most rapidly on either side of the green. Can there be any significance in the fact that the change of brightness and the change of tone are both most rapid in the same part of the spectrum, namely, in the yellow and the blue? C. L. F.

Experimentelle Untersuchungen über die psychophysische Fundamentalformel in Bezug auf den Gesichtsinn. Dr. ARTHUR KÖNIG und Dr. EUGEN BRODHUN. Sitzungsber. der König. Preuss. Akademie der Wissensch. zu Berlin, 1888, pp. 15.

Doubting the applicability of the psychophysic law to light illuminations, these experimenters decided to find the differential threshold with various intensities, from the slightest barely perceptible illuminations up to intense brightness, almost glaring. The light was of six different spectral wave-lengths, 670$\mu\mu$, 575$\mu\mu$, 505$\mu\mu$, 470$\mu\mu$ and 430$\mu\mu$, these answering to the fundamental colors of their visions. König has normal color perception, but Brodhun is green blind. Their rather intricate apparatus and method of observation need not be detailed; the final problem in each observation consisted in adjusting one rectangular patch of spectral light so that it appeared just noticeably darker than another. The intensity of the illumination was varied for each wave-length from 1 upwards to 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10,000, 20,000, 50,000, and 100,000, and downwards to .5, .2 and .1, the light 1 being the illumination seen by an eye looking through a diaphragm one square millimeter in aperture, at a surface coated with oxide of magnesium, the surface standing at a distance of one meter, and reflecting the light from a glowing platinum surface one-tenth square centimeter in area, standing parallel to it. Grouping all the wave-lengths together, it is found that between intensities 100,000 and 20 there is a very regular slight increase in sensibility, followed by an equally regular and slight decrease, the sensibility between inten-

sities 1000 to 20,000 being very nearly the same. The curve for this region would thus be a shallow trough. The average value of the sensibility between 100,000 and 20 is about 1/44. They also conclude (1) that the variations between the two observers are so slight as to show that the differences in their color distinctions do not affect the results; (2) that from the highest intensities down to 100 or 20, the wave-length does not affect the sensibility, the latter being a function of the illumination only; (3) that the three wave-lengths $670\mu\mu$, $605\mu\mu$ and $575\mu\mu$ form one group, and $505\mu\mu$, $470\mu\mu$ and $430\mu\mu$ form another group, the sensibility decreasing more rapidly with the latter than with the former. Again, the intensity of the light distinguishable from darkness was, from the longest to the shortest wave-lengths, .11, .011, .0055, .00035, .00013, .00014 intensities respectively. A very important conclusion that the authors draw is that with a brightness *subjectively* the same, the sensibility is independent of the wave-length; in other words, the same physical intensity in various colors does not appear the same psychically; and it is the latter that is the standard, not the former. J. J.

On some peculiarities of the phantom images formed by binocular combination of regular figures. JOSEPH LE CONTE. Am. Jour. of Science, 3d series, XXXIV (1887).

The observations presented by Prof. Le Conte are four. (1) On looking downward at about 45° on a regular repeated pattern like that of an oil-cloth, and combining the patterns by crossing the eyes, the observer sees the phantom plane raised at the adjacent end, the elevation increasing as figures farther and farther apart are combined. The reason is that the rows of figures as they run forward from the observer slant inward (except the middle one) by mathematical perspective. As lines of figures with greater and greater slant are made by the crossing of the eyes to serve as the middle one of the field, they cross at greater and greater angles. Since this is what would actually be present if the observer were looking down a sloping plane, the image is involuntarily interpreted after that analogy. The individual figures appear elongated because referred to such a plane. The reverse effect is here as elsewhere to be obtained by combining the images with parallel lines of sight. (2) If a vertical plane is taken, on looking upward or downward the image inclines away in the direction of sight. (3) If the eyes are kept at the neutral point (about 7° above the horizontal for Prof. Le Conte himself), no such sloping is seen (if anything, the reverse curvature), but the plane falls away at the sides. If, however, the eyes are moved upward and downward, both curvatures appear. The sides are seen sloping because the points of the real plane to the right and left of the fixation point are represented on retinal points that belong to homonymous images, and are therefore interpreted as beyond the fixation point. (4) If the vertical surface is bent on its vertical diameter, like a half-open book seen from behind or before, the convex (or concave) effect is increased, as with the Le Conte Stephens stereoscope (Am. Jour. Sc. 3d series, XXIII, 297 ff.), but this increase is due to geometrical, not to retinal causes. The curvature of the plane in the third observation is a corollary of the circular form of the horopter in such a position of the eyes.